

What Is Claimed Is:

1 1. A method for matching speeds of asynchronous operation between
2 a local chip and a neighboring chip, the method comprising:
3 deriving an internal frequency signal from an internal oscillator on the
4 local chip;
5 receiving an external frequency signal from a neighboring chip;
6 comparing the internal frequency signal with the external frequency signal
7 to generate a control signal;
8 adjusting the operating speed of the local chip by applying the control
9 signal to the local chip; and
10 adjusting the frequency of the internal oscillator by applying the control
11 signal to the internal oscillator.

1 2. The method of claim 1, wherein adjusting the frequency of the
2 local chip involves changing the power-supply voltage of the local chip.

1 3. The method of claim 1, wherein receiving of the external frequency
2 signal from the neighboring chip involves receiving the external frequency signal
3 through a capacitor, an inductor, a resistor, a transmission line, or a direct contact.

1 4. The method of claim 1, wherein comparing the internal frequency
2 signal with the external frequency signal involves converting the internal
3 frequency signal and external frequency signal into corresponding current or
4 voltage signals, which are proportional to the frequencies of the frequency signals.

1 5. The method of claim 4,

2 wherein the internal frequency signal and the external frequency signal are
3 converted into corresponding current signals;
4 wherein comparing the internal frequency signal with the external
5 frequency signal involves comparing the two current signals to generate a
6 difference current signal; and
7 wherein the method further comprises:
8 coupling the difference current signal to an integrating capacitor to
9 produce an integrated voltage signal;
10 applying an offset current source to the integrating capacitor to
11 compensate for transistor leakages, parasitics, and/or nonlinearities; and
12 coupling the integrating capacitor to an amplifier, wherein the
13 input to the amplifier is the integrated voltage signal and the output of the
14 amplifier is the control signal.

1 6. The method of claim 1, further comprising filtering the control
2 signal to improve matching between the local chip's operating speed and the
3 neighboring chip's operating speed.

1 7. The method of claim 6, wherein filtering the control signal
2 involves coupling a filter capacitor between the control signal and ground.

1 8. The method of claim 1, wherein
2 the internal frequency signal has a frequency that is a fraction of the
3 internal oscillator frequency of the local node; and wherein
4 the external frequency signal has a frequency that is a fraction of an
5 external oscillator frequency of the neighboring node.

1 9. An apparatus for matching speeds of asynchronous operation
2 between a local chip and a neighboring chip, the apparatus comprising:
3 an internal oscillator on the local chip, from which an internal frequency
4 signal can be derived;
5 a receiving mechanism configured to receive an external frequency signal
6 from a neighboring chip;
7 a comparison mechanism configured to compare the internal frequency
8 signal with the external frequency signal to generate a control signal; and
9 an adjusting mechanism configured to adjust the operating speed of the
10 local chip and the internal oscillator by applying the control signal to the local
11 chip and the internal oscillator.

1 10. The apparatus of claim 9, wherein the adjusting mechanism is
2 configured to adjust the frequency of the local chip by changing the power-supply
3 voltage of the local chip.

1 11. The apparatus of claim 9, wherein the receiving mechanism is
2 configured to receive the external frequency signal from the neighboring chip
3 through a capacitor, and inductor, a resistor, a transmission line, or a direct
4 contact.

1 12. The apparatus of claim 9, wherein the comparison mechanism is
2 configured to convert the internal frequency signal and the external frequency
3 signal into corresponding current or voltage signals, which are proportional to the
4 frequencies of the frequency signals.

1 13. The apparatus of claim 12,

2 wherein the external frequency signal and the internal frequency signal are
3 converted into corresponding current signals;
4 wherein the comparison mechanism is configured to compare the two
5 current signals to generate a difference current signal; and
6 wherein the apparatus further comprises:
7 an integrating capacitor to which the difference current signal is
8 coupled to produce an integrated voltage signal;
9 an offset current source applied to the integrating capacitor to
10 compensate for transistor leakages, parasitics, and/or nonlinearities; and
11 an amplifier to which the integrating capacitor is coupled, wherein
12 the input to the amplifier is the integrated voltage signal and the output of
13 the amplifier is the control signal.

1 14. The apparatus of claim 9, further comprising a filtering mechanism
2 configured to filter the control signal to improve matching between the local
3 chip's operating speed and the neighboring chip's operating speed.

1 15. The apparatus of claim 14, wherein the filtering mechanism
2 includes a filter capacitor coupled between the control signal and ground.

1 16. The apparatus of claim 9, wherein
2 the internal frequency signal has a frequency that is a fraction of the
3 internal oscillator frequency of the local node; and wherein
4 the external frequency signal has a frequency that is a fraction of an
5 external oscillator frequency of the neighboring node.

1 17. A computer system that includes a circuit for matching speeds of
2 asynchronous operation between a local chip and a neighboring chip, the circuit
3 comprising:
4 a central processing unit;
5 a semiconductor memory;
6 an internal oscillator circuit on the local chip, from which an internal
7 frequency signal can be derived;
8 a receiver circuit for receiving an external frequency signal from a
9 neighboring chip;
10 a comparison circuit for comparing the internal frequency signal with the
11 external frequency signal to generate a control signal; and
12 an adjustment circuit for adjusting the operating speed of the local chip
13 and the internal oscillator by applying the control signal to the local chip and the
14 internal oscillator.

1 18. The computer system of claim 17, wherein the adjustment circuit is
2 configured to adjust the frequency of the local chip by changing the power-supply
3 voltage of the local chip.

1 19. The computer system of claim 17, wherein the receiver circuit is
2 configured to receive the external frequency signal from the neighboring chip
3 through a capacitor, and inductor, a resistor, a transmission line, or a direct
4 contact.

1 20. The computer system of claim 17, wherein the comparison circuit
2 is configured to convert the internal frequency signal and the external frequency

3 signal into corresponding current or voltage signals, which are proportional to the
4 frequencies of the frequency signals.

1 21. The computer system of claim 20,
2 wherein the external frequency signal and the internal frequency signal are
3 converted into corresponding current signals;
4 wherein the comparison circuit is configured to compare the two current
5 signals to generate a difference current signal; and
6 wherein the computer system further comprises:
7 an integrating capacitor to which the difference current signal is
8 coupled to produce an integral voltage signal;
9 an offset current source applied to the integrating capacitor to
10 compensate for transistor leakages, parasitics, and/or nonlinearities; and
11 an amplifier to which the integrating capacitor is coupled, wherein
12 the input to the amplifier is the integral voltage signal and the output of the
13 amplifier is the control signal.

1 22. The computer system of claim 17, further comprising a filtering
2 circuit for filtering the control signal to improve matching between the local
3 chip's operating speed and the neighboring chip's operating speed.

1 23. The computer system of claim 22, wherein the filter circuit
2 includes a filter capacitor coupled between the control signal and ground.

1 24. The computer system of claim 17, wherein
2 the internal frequency signal has a frequency that is a fraction of the
3 internal oscillator frequency of the local node; and wherein

4 the external frequency signal has a frequency that is a fraction of an
5 external oscillator frequency of the neighboring node.
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